The Genus *Physaria* (Brassicaceae) in South America

Steve L. O'Kane, Jr.
Department of Biology, University of Northern Iowa, Cedar Falls, Iowa 50614-0421, U.S.A.
steve.okane@uni.edu

Ihsan A. Al-Shehbaz
Missouri Botanical Garden, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A.
ihsan.al-shehbaz@mobot.org

ABSTRACT. Three new Argentinian species of *Physaria*, *P. crassistigma*, *P. lateralis*, and *P. pygmaea*, are described and illustrated. The new combinations *P. mendocina* and *P. urbaniana* are proposed. A key to the five South American species of *Physaria* is given. Brief comments are presented on the disjunction of these South American species and their relationships to their North American relatives.

RESUMEN. Se describen e ilustran tres especies argentinas de *Physaria*, *P. crassistigma*, *P. lateralis* y *P. pygmaea*. Se proponen dos nuevas combinaciones: *P. mendocina* y *P. urbaniana*. Se provee una clave para las cinco especies de *Physaria* sudamericanas. Se presentan comentarios breves acerca de la disyunción de estas especies sudamericanas y de los parentescos con sus parientes norteamericanos.

Key words: Argentina, Brassicaceae, *Lesquerella*, *Physaria*, South America.

As delimited herein, the genus *Physaria* (Nuttall ex Torrey & A. Gray) A. Gray includes all except eight species previously recognized by various authors in *Lesquerella* S. Watson (e.g., Rollins & Shaw, 1973; Rollins, 1993, 1995; Rollins et al., 1996; Anderson et al., 1997; O'Kane, 1999). For detailed discussions justifying the reduction of *Lesquerella* to synonymy of *Physaria*, see O'Kane et al. (1999) and Al-Shehbaz and O'Kane (2002). The eight auriculate-leaved species previously recognized in *Lesquerella* are now treated in the genus *Paysonia* O'Kane & Al-Shehbaz (O'Kane & Al-Shehbaz, 2002). Although members of *Physaria* in North America have been the subject of several monographic treatments (Payson, 1921; Rollins, 1939, 1993; Rollins & Shaw, 1973), no similar analysis is available for species in South America. In their monograph of the genus *Lesquerella*, Rollins and Shaw (1973: 1) stated that "the entire genus includes about a dozen species which occur in South America from southern Bolivia southward, but we have not studied these sufficiently to include them in the present treatment." Rollins did, in the early 1960s, begin looking at the genus in South America. We know this because his widow was kind enough to make his handwritten notes available to us. It is clear from reading these that at that time few specimens were available for study. We judge that sufficient materials are now available and that a preliminary assessment can be made of the genus in South America. While it would not surprise us if intensive field and laboratory work were to uncover as many as a dozen species, we here recognize five.

HISTORY OF THE SOUTH AMERICAN TAXA

The first South American collection assigned to what is now known as *Physaria* was based on material collected by J. Gillies from Santiago of Mendoza (Argentina) and determined by Barnéoud (1846) as the North American (Canada, Alaska) and northern Russian *Vesicaria arctica* Hooker. Philippi (1864) recognized that same collection as the new species *V. mendocina*. A year later, Eichler (1865) described *V. montevidensis* Eichler based on material collected by Sello from Montevideo (Uruguay). These two species were transferred to *Lesquerella* by Kurtz (1893) and Watson (1888), respectively. Muschler (1908) described two species of *Alyssum*, *A. boliviense* Muschler and *A. urbanianum* Muschler, which were reduced by Payson (1921) to synonymy of *L. mendocina* (Philippi) Kurtz. In addition to *L. mendocina*, Payson recognized *L. montevidensis* (Eichler) S. Watson and the Venezuelan *L. frigida* (Turczaninow) Payson, though he did not examine any material of these two species. Furthermore, the material he cited under *L. mendocina* does not belong to this species. Rollins (in Rollins & Shaw, 1973) was correct in excluding *L. frigida* from *Lesquerella* and placing it

in *Draba*, but the new name he proposed, *D. obscura* Rollins, was a later homonym, and the correct name of the species is *D. farsetioides* Linden & Planchon. Schulz (1934) described a new variety, *L. mendocina* var. *microcarpa* O. E. Schulz, and later (Schulz, 1936) treated both *A. boliviense* and *A. urbanianum* as synonyms of this variety. Subsequent accounts of *Lesquerella* from South America (e.g., Boelcke, 1967; Boelcke & Romanczuk, 1984) recognized only *L. mendocina* and overlooked the fruit diversity and habit that clearly divide the complex into five well-defined species (see Figs. 1–3).

The present account is provincial and is based primarily on material deposited in major herbaria. Fieldwork is needed to collect material for cytological and molecular studies and to fully understand the range of variation of each species. Although Manton (1932) reported $2n$ = ca. 50 for *Physaria* (as *Lesquerella*) *mendocina*, she did not leave voucher specimens that would enable the verification of the true identity of the species. Furthermore, this chromosome number clearly reflects a polyploidy level much higher than those compiled by Rollins and Shaw (1973) for the North American taxa (except the boreal *P. arctica* (Wormskjöld ex Hornemann) O'Kane & Al-Shehbaz with $2n$ = 60).

Morphological data indicate that the five South American species, which are limited to Argentina and immediately adjacent Bolivia and Uruguay, are basically indistinguishable in trichome type and density, shape of basal and cauline leaves, flower size and color, fruit indumentum, number of ovules/seeds per ovary/fruit, seed shape and size, and cotyledonary position. Petals in these species often fade, especially on drying, to pink or purple, a condition rarely seen in the North American species. These remarkable similarities support the hypothesis that the five species probably had a common origin from a North American ancestor and that it is likely that their migration into South America was a single event. Preliminary molecular studies by O'Kane (in progress) seem to support such an origin.

KEY TO THE SOUTH AMERICAN SPECIES OF *PHYSARIA*

1a. Style 0.7–1.5 mm long; stigma broadly capitate, considerably wider than style; fruit wider than long, subinflated . . . . . 3. *P. crassistigma*
1b. Style (2.5–)3–6(–8) mm long; stigma capitate, slightly wider than style; fruit as long as or longer than wide, not inflated.
  2a. Fruits terete.
    3a. Stems erect to ascending, often arising from the center of rosette; basal leaves dentate or repand-dentate; cauline leaves (7 to)9 to 17(to 25), ± spirally arranged; fruiting pedicels sigmoid or rarely straight . . . . . 1. *P. mendocina*
    3b. Stems procumbent to decumbent, arising laterally from the rosette; basal leaves entire; cauline leaves 3 to 11(to 16), secund; fruiting pedicels straight or inwardly curved but very rarely sigmoid . . . . . 2. *P. lateralis*
  2b. Fruits angustiseptate.
    4a. Stems (5- to) 7- to 18(to 28)-leaved, 3–13(–15) cm long; racemes (4)5- to 9(to 13)-flowered; petals 8–10(–13) × 3.5–5.5(–7) mm; fruits (6.5–)7–9(–10) × (4–)5–7 mm; fruiting pedicels sigmoid . . . . . 4. *P. urbaniana*
    4b. Stems leafless or 1- to 3(or 4)-leaved, to 1.3 cm long; racemes 1- to 3(or 4)-flowered; petals 4–5(–6) × ca. 2 mm; small fruits 4–5(–8) × 3–4(–5) mm; fruiting pedicels not sigmoid . . . . . 5. *P. pygmaea*

Physaria (Nuttall) A. Gray, Gen. Fl. Amer. Bor.-Orient. 1: 162. 1848 [1849]. TYPE: *Physaria didymocarpa* (W. J. Hooker) A. Gray (*Vesicaria didymocarpa* W. J. Hooker).

1. Physaria mendocina (Philippi) O'Kane & Al-Shehbaz, comb. nov. Basionym: *Vesicaria mendocina* Philippi, Linnaea 33: 12. 1864. *Alyssum mendocinum* (Philippi) Kuntze, Revis. Gen. Pl. 2: 931. 1892. *Lesquerella mendocina* (Philippi) Kurtz, Revista Mus. La Plata 5: 286. 1893. TYPE: Argentina. Mendoza: "ad radicem Andium," *Wenceslav Diaz s.n.* (holotype, SGO).

Vesicaria montevidensis Eichler, in Martius, Fl. Brasil. 13(1) 302. 1865. *Lesquerella montevidensis* (Eichler) S. Watson, Proc. Amer. Acad. Arts 23: 251. 1888. TYPE: Uruguay. Near Montevideo, *Sello s.n.* (holotype, B).

Perennial herbs, sparsely to densely silvery pubescent throughout with stellate trichomes; caudex often slender, sometimes much elongated and rhizome-like, rarely thick and woody, simple or branched, sometimes with leaf remnants of previous years, branches terminated by leaf clusters; stems few or rarely many, erect or ascending, often arising from middle of rosette, (6–)10–45(–60) cm long. Basal leaves with petioles (1–)1.5–4(–5) cm long; leaf blade spatulate to oblanceolate, rarely linear-oblanceolate, (1–)2.5–7(–8) cm × 3–12(–15) mm, base attenuate to cuneate, margin dentate to repand-denticulate, rarely entire, apex obtuse to subacute; cauline leaves (7 to)9 to 17(to 25), ± spirally arranged, spatulate to narrowly oblanceolate, subsessile or short petiolate, base cuneate to attenuate, margin dentate or entire, apex obtuse or acute. Ra-

ceme 16- to 30-flowered, often elongated considerably in fruit; fruiting pedicels sigmoid or rarely straight, divaricate or rarely ascending or slightly reflexed, densely pubescent, slender, (5–)8–17(–25) mm long. Sepals narrowly oblong, non-saccate at base, silvery pubescent, 4.5–7.5 × 1.5–2 mm, caducous; petals pale to bright yellow, drying pink or purplish, obovate, 8–12 × 4.5–6.5 mm, apex rounded; filaments 5–8 mm long; anthers oblong, 1–1.5 mm long. Fruit globose, globose-ellipsoid, or ovoid, rarely obovoid, 4.5–6.5(–8) × 3.5–5 mm, terete, sparsely pubescent, sessile or on a stipe to 0.5 mm long, base obtuse or subacute, apex obtuse; ovules/seeds 4 to 8 per locule; style slender, (2.5–)3–6(–8) mm long, glabrous or sparsely pubescent basally; stigma only slightly wider than style; seeds compressed, ovate to ovate-orbicular, wingless, 2–2.7 × 1.5–2 mm; cotyledons accumbent.

Phenology, distribution, and elevation. Flowering late September through December, fruiting mid October to early February in Argentina (Buenos Aires, Córdoba, La Pampa, Mendoza, Neuquén, Río Negro, and San Luís) and Uruguay at 250–1600 m.

Physaria mendocina is the most widespread and variable of all of the South American species of *Physaria.* Although the caudex is few-branched in most specimens examined, in *Rentzell 1109* (F, SI), the caudex is much elongated and rhizome-like. The basal leaves are coarsely dentate, though in *Cabrera s.n.* (SI) subentire leaves are found in the same population that otherwise has dentate leaves, and in very rare cases, *Ameghino s.n.* (BA), the basal leaves are entire, linear, and to 1 mm wide. The fruiting pedicels in most samples examined are slightly sigmoid, but in *Gomez et al. 2791* (BAA, CTES) they are strongly sigmoid and somewhat reflexed, whereas in *Cano 2698* (BAA) they are straight and ascending and in *Barkley 20Mz207* (F, W) the lowermost are up to 2.5 cm long. Fruit shape can also vary in the same population, and in *Cámara et al. 15* (BAA) the fruits vary from typically globose to obovoid with a subacute base. One collection, *Comber 856* (E, K), has the largest flowers (petals ca. 12 × 6 mm and style to 7 mm long) in the species. The specimen at K was annotated by Reed C. Rollins as the holotype of "Lesquerella comberi Rollins," a name that was never published. The variation in all parts of the plant, however, does not form any coherent patterns that would allow the recognition of infraspecific taxa.

Physaria mendocina occupies the lowermost altitudes (250–1600 m vs. (1000–)1700–4400 m) among the Argentinian species of the genus. Its probable nearest relative, *P. lateralis,* occupies somewhat higher elevations, though their distributional ranges overlap in several areas. In one case of such sympatry, *Hunziker 7553* (GH), no intermediates between the two species have been found.

The illustration of *Physaria mendocina* in Boelcke and Romanczuk (1984: 455) accurately shows the overall habit, flowers, and fruit of the species, but the trichomes were erroneously drawn because they show all rays rigid and unbranched, when in fact they are slender and branched, as in all of the South American species of *Physaria.*

Representative specimens examined. ARGENTINA. **Buenos Aires:** Partido de Tornquist, Sierra de la Ventana, Cerro de la Ventana, *Cabrera s.n.* (GH, SI), *Gómez et al. 2791* (BAA, CTES); Ptdo. Cnel. Dorrego, Monte Hermosa, *Eskuche 647* (BAA); Monte Hermoso, Part. Leonardo Rosals, *Verihoni 2562* (BAA); Claromecó, Part. Tres Arroyos, *Verihoni 2553* (BAA); Choique, *Parodi 13756* (BAA); Pique, Sierra de la Ventana, *Rentzell 1109* (F, SI). **Córdoba:** Malaguezo, *Hunziker 6731* (GH); Villa Brochero, *Castellanos 10519* (BA); Sierra Chica, Mina del Tauro, *Castellanos 24/463* (BA); Dept. Talumba, San Pedro Norte, *Albelló 12022* (BAA); Cuesta de San Iguaçu, *Kurtz 2859* (R); Cerritos de Malgueño, *A. T. Hunziker 7553* (GH); San Estaban, *Nicore 1622* (BAA). **La Pampa:** Pque. Nac. Lihuel Calel, *Cámara et al. 15* (BAA, MO); Dpto. Leventué, rutal 148, Cerro, *Cano 2698* (BAA). **Mendoza:** 20 km al suroeste de Campo de los Andes, *Barkley 20Mz207* (F, W); Lujan, Cerro Cacheuta, *Leal 12747* (P); Rio Diamente, near San Rafail, *Böcher et al. 677* (BAA, MO). **Neuquén:** Vega Lolog, *Comber 856* (E, K). **Río Negro:** Viedma, médanos del Faro, *Castellanos 28/1134* (BA); Rio Negro inférieur, *Février 3793* (BA); Dpto. San Antonio, Sierra Gran de Yacimiento ferrigero Sur, proc a Loma Blanca, *Piccinini & Garcia 1591* (BAA); Paso Flores, *Schajovskoy 308* (M). **San Luís:** Sierra Varela, *Castellanos 25/2836* (BA); Dpto. La Capital, Ruta provincial no. 3 ingreso a la Cantera San José, *Del Vitto et al. 6315* (CTES); Cropuche, *Varelov 661* (S). URUGUAY. **Paysandu:** Chapicuy-Orillas del Río Uruguay, mesita de Atiga, n.d., *Rossengurtt 4193* (BAA).

2. Physaria lateralis O'Kane & Al-Shehbaz, sp. nov. TYPE: Argentina. San Luís: Dpto. Pringles, entre El Totoral y La Arenilla, 7 Jan. 1989, *Luis A. Del Vitto, Elisa Petenatti & M. Pagliarone 2970* (holotype, CTES; isotype, UNSL). Figure 1.

Lesquerella mendocina (Philippi) Kurtz var. *microcarpa* O. E. Schulz, Notizbl. Bot. Gart. Berlin-Dahlem 12: 41. 1934. TYPE: Argentina. San Luís: Sierra de San Luís, Peñon Colorado, 18 Dec. 1929, *A. Castellanos 29/333* (holotype, B; isotype, BA).

Herba perennis, (3–)4–24 cm longa, caudicibus tenuibus vel crassis, simplicibus vel ramosis; caules procumbentes vel decumbentes. Folia basalia integra; folia caulina 3–11(–16), secunda. Racemi (5–)7–20(–27)-flori; pedicelli fructiferi recti vel curvati, 5–10 mm longi. Petala

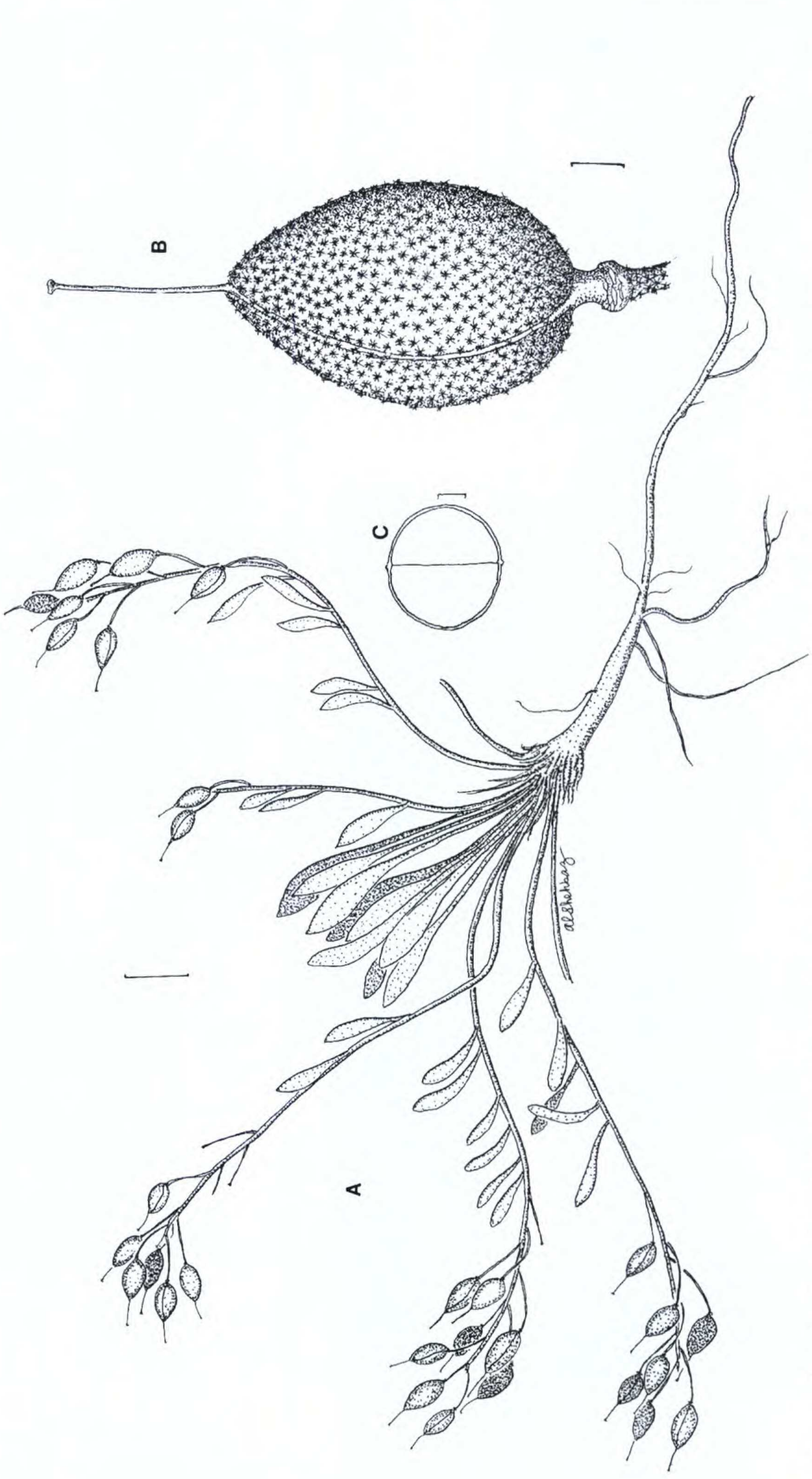

Figure 1. *Physaria lateralis* O'Kane & Al-Shehbaz. —A. Plant. —B. Fruit. —C. Diagrammatic cross section of fruit. Scale: A = 1 cm; B, C = 1 mm. Drawn by Al-Shehbaz from the holotype, *Del Vitto et al. 2970* (CTES).

obovata, 7–11 × 3–5 mm. Fructus globosi, ovoidei, vel subellipsoidei, teretes, (3.5–)4–7 × 3–5(–6) mm, basi et apice obtusi; stylus tenuis, (2.5–)3–5(–6) mm longus; stigma tenue.

Perennial herbs, sparsely to densely silvery pubescent throughout with stellate trichomes; caudex slender or stout, woody, simple or rarely few-branched, sometimes with leaf remnants of previous years; stems few to several, procumbent to decumbent, arising from outside of rosette, (3–)4–24 cm long. Basal leaves with petioles 0.5–1.5(–3) cm long; leaf blade oblanceolate, rarely linear-oblanceolate or spatulate, 1.5–3.5 cm × 3–7 mm, base attenuate to cuneate, margin entire, apex acute to subobtuse; cauline leaves 3 to 11(to 16), ± secund, linear to narrowly oblanceolate, subsessile, base attenuate, margin entire, apex subacute. Raceme (5-to)7- to 20(to 27)-flowered, elongated in fruit; fruiting pedicels straight or curved inward, very rarely sigmoid, divaricate or ascending, densely pubescent, slender, 5–10 mm long. Sepals narrowly oblong, non-saccate at base, silvery pubescent, 4–6 × 1.5–2 mm, caducous; petals pale to bright yellow, drying pink or purplish, obovate, 7–11 × 3–5 mm, apex rounded; filaments 4–5.5 mm long; anthers oblong, 1–1.5 mm long. Fruit globose, ovoid to subellipsoid, (3.5–)4–7 × 3–5(–6) mm, terete, sparsely pubescent, sessile or on a stipe to 0.5 mm long, base and apex obtuse; ovules/seeds 2 to 5 per locule; style slender, (2.5–)3–5(–6) mm long, glabrous or sparsely pubescent basally; stigma only slightly wider than style; seeds compressed, ovate to ovate-orbicular, wingless, 1.8–2.5 × 1.2–2 mm; cotyledons accumbent.

Phenology, distribution, and elevation. Flowering late September through December, fruiting mid October to early February in Argentina (Córdoba, Mendoza, Neuquén, and San Luís) at (1000–)1700–2950 m.

Physaria lateralis, which derives its name from the lateral origin of branches in relation to the basal rosette, most closely resembles *P. mendocina*, especially in flower and fruit morphology, but it differs by having procumbent to decumbent stems arising laterally from the rosette, entire basal leaves, secund, 3 to 11(to 16) cauline leaves, straight or inwardly curved but rarely sigmoid fruiting pedicels, and ovaries/fruits generally with 2 to 4(or 5) ovules/seeds per locule. By contrast, *P. mendocina* has erect to ascending stems arising from the center of the rosette, at least some dentate or repand-dentate basal leaves, spirally arranged, (7 to)9 to 17(to 25) cauline leaves, sigmoid or rarely straight fruiting pedicels, and ovaries/fruits generally with (4 or)5 to 8 ovules/seeds per locule.

The fruits of *Physaria lateralis* exhibit the same pattern of variation seen in *P. mendocina*, and the type collection of *P. lateralis* has fruits ranging in shape from globose to subellipsoid. Contrary to *P. mendocina*, which has primarily sigmoid fruiting pedicels, those of *P. lateralis* are straight or curved inward, and only rarely are they sigmoid, as in *Sleumer 435* (B).

Physaria lateralis is indistinguishable from *Lesquerella mendocina* var. *microcarpa* in every aspect. Since that varietal name has priority only at its rank, we had the choice to either raise it to the specific rank or describe the taxon as a new species based on a different type. We prefer the latter action and base the new species on more complete material, instead of proposing a new combination based on the fragmentary type collection of variety *microcarpa*.

Paratypes. ARGENTINA. **Córdoba:** Nono, entre Mina Clavero y Villa Dolores, *A. T. Hunziker 7849* (BAA); Cerritos de Malgueño, *A. T. Hunziker 7553* (GH); Taninga, 15 km W camino Los Tuneles, *O. Boelcke 7725* (BAA), *O. Boelcke 7726* (BAA); Camino M Clavero–La Plata (Pampa de Achala), *O. Boelcke 7783* (BAA), *Tirel 406* (P); Pampa de Pocho, *Ragonese & Piccinini 9734* (BAA); Los Coquitos, Dpto. Ischilín, *T. M. Pedersen 9926* (BAA, K). **Mendoza:** Queb. Chacay, Cord. Del Tigre, *D. O. King 346* (BM); Tupungato, *H. Sleumer 435* (LIL), *F. O. Roig 160* (BAA), *R. Leal 3643* (LIL); halfway betw. Fort San Rafael & El Purito del Monte, *J. Gillies s.n.* (GH); Dpto. San Rafael, Sa. del Nevado, laderas entre La Cienaguita y el Zanjón del Plateado, *O. Boelcke et al. 15973* (BAA); pampa entre arroyo Agua del Guacho y el zanjón del Plateado al S-SE del los Cos. Morados, *O. Boelcke et al. 15611* (BAA), *O. Boelcke et al. 15709* (BAA), *O. Boelcke et al. 15738* (BAA); laderas alrededor de la Cienaguita, *O. Boelcke et al. 15679* (BAA); Tunuyán, Puesto Gendarmería Alférez Portinari, Ao. Cascada del la Vieja, *O. Boelcke et al. MC272* (BAA); Tupungate, Río La Carrera, *O. Paci & O. Melis 96* (GH); Potrerillos, estancia "El Salto," *Ragonese 12589* (GH); betw. Rt. 40 & Lag. Diamante, *T. W. Böcher et al. 2049* (BAA); Atuel Valley near the outlet of Arroyo Blanco, *T. W. Böcher et al. 1044* (BAA). **Neuquén:** Dpto. Catán-Lil, Rt. 40 a 5 km S de Ao. China Muerta, *J. Vallerini & J. Brun 654* (BAA). **San Luís:** Sierras, del San Luis Peñón Colorado, *A. Castellanos 29/333* (B, BA); Pancanta, *A. Castellanos 25/705* (BA); Comechingones, *A. Castellanos 25/2576* (BA); Altp Rodeo X Piscada del Gigante, *A. Castellanos 26/2112* (BA); Dept. Pringles, Valle de Pan canta, Hostería "Las Verbenas," *J. G. Hawkes et al. 3176* (BAA); Dpto. Pringles, ruta prov. 9, entre Los Tapiales y La Arenilla, *R. Kiesling et al. 4724* (SI); 5 km NE of Carolina, *R. R. Brooks et al. MS121* (MO).

3. **Physaria crassistigma** O'Kane & Al-Shehbaz, sp. nov. TYPE: Argentina. Mendoza: Dpto. Las Heras, Estancia San Isidro, Pampa de Los Ñangos, 2450 m, 14 Jan. 1964, *Ruiz Leal 23145* (holotype, BAA). Figure 2.

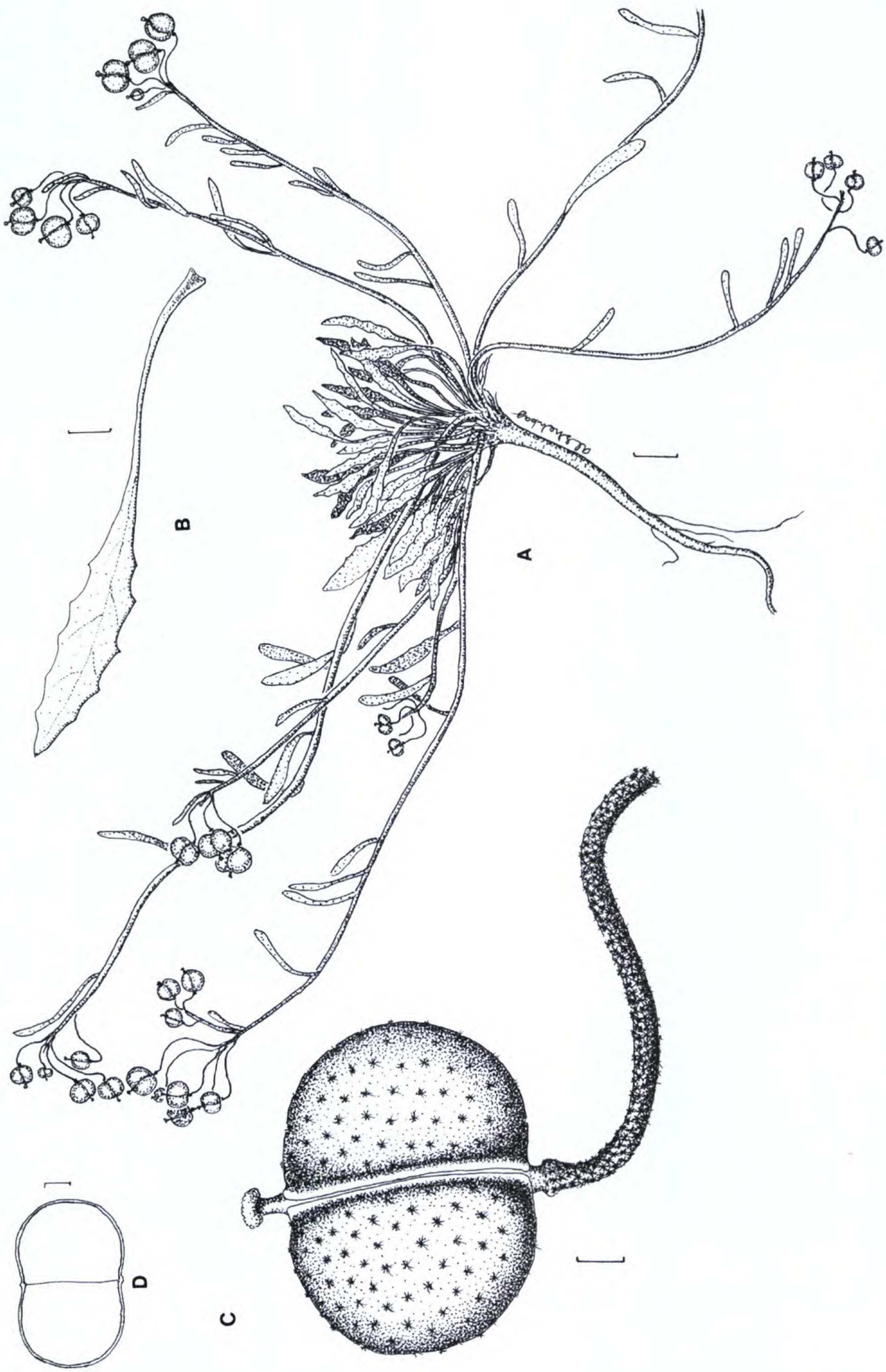

Figure 2. *Physaria crassistigma* O'Kane & Al-Shehbaz. —A. Plant. —B. Basal leaf. —C. Fruit and fruiting pedicel. —D. Diagrammatic cross section of fruit. Scale: A = 1 cm; B = 5 mm; C, D = 1 mm. Drawn by Al-Shehbaz from the holotype, *Leal 23145* (BAA).

Herba perennis, 2–18(–23) cm longa, caudicibus crassis, simplicibus; caules procumbentes vel decumbentes. Folia basalia dentata vel dentato-repanda; folia caulina (3–)5–13(–15), spiraliter vel subsecunda. Racemi 5–10(–18)-flori; pedicelli fructiferi sigmoidei, (5–)6–12(–17) mm longi. Petala obovata, 9–11 × 4–5 mm. Fructus subglobosi, subinflati, teretes, latiores quam longiores, 4.5–6 × 5–8 mm, basi subcordati vel obtusi, apice subemarginati vel subtruncati; stylus crassis, 0.7–1.5 mm longus; stigma crassum.

Perennial herbs, sparsely to densely silvery pubescent throughout with stellate trichomes; caudex often stout, woody, simple or rarely branched, often with leaf remnants of previous years; stems few or several, procumbent or decumbent, 2–18(–23) cm long. Basal leaves with petioles 0.7–2 cm long; leaf blade oblanceolate, rarely linear-oblanceolate, 1–2.7 cm × 2–6 mm, base attenuate to cuneate, margin dentate to repand-denticulate, apex obtuse to subacute; cauline leaves (3 to)5 to 13(to 15), spirally arranged or subsecund, linear to linear-oblanceolate, subsessile or short-petiolate, base cuneate to attenuate, margin repand or entire, apex obtuse or acute. Raceme 5- to 10(to 18)-flowered, elongated slightly in fruit; fruiting pedicels strongly sigmoid, divaricate or rarely ascending, densely pubescent, slender, (5–)6–12(–17) mm long. Sepals narrowly oblong, non-saccate at base, silvery pubescent, 5–7 × 1.5–2 mm, caducous; petals pale to bright yellow, drying pink or purple, obovate, 9–11 × 4–5 mm, apex rounded; filaments 4–5 mm long; anthers oblong, 1–1.5 mm long. Fruit subglobose, subinflated, wider than long, 4.5–6 × 5–8 mm, terete, sparsely pubescent, sessile or on a stipe to 0.5 mm long, base subcordate to obtuse, apex subemarginate to subtruncate; ovules/seeds 4 to 8 per locule; style stout, 0.7–1.5 mm long, glabrous; stigma broadly capitate, considerably wider than style, sometimes as wide as style length; seeds compressed, ovate to ovate-orbicular, wingless, 2–2.5 × 1.5–2 mm; cotyledons accumbent.

Phenology, distribution, and elevation. Flowering early November through December, fruiting late November to early January in Argentina (Mendoza) at 2200–2900 m.

The characteristically short (0.7–1.5 mm) style, broadly capitate stigma considerably wider than the style, and often apically and basally depressed fruits wider than long readily distinguish *Physaria crassistigma* from the other South American species of the genus. The species resembles *P. mendocina* in having dentate or dentate-repand basal leaves and nearly similar flower size and number of ovules per locule. The two species can easily be distinguished in flower by the examination of style and stigma: short styles and broad stigmas in *P. crassistigma*, and slender styles and narrow stigmas in *P. mendocina*.

Paratypes. ARGENTINA. **Mendoza:** Dpto. Lujan de Cuyo ± 500 m al w de Puesto Reinoso Cno a Vallecitos, Barranca al Rio Blanca, *D. Medan et al. 879* (BAA); Sierra del Plata, *D. O. King 119* (BM); Los Arenales, Villavicencio & San Rafael, Andes of Mendoza, *J. Gillies s.n.* (K); Aleli del Campo, between Los Liacayus & Los Arenales, *J. Gillies s.n.* (K); Los Cerros del Morro, del Portuzecelo, Prov. of San Luís and Los Arenales, San Rafael, Andes of Mendoza, *J. Gillies 16* (E); Vallecito, *H. L. Hauman 1318* (BA); Dpto. Las Heras, Villavicencio, *H. Sleumer 513* (B); Dpto. Las Heras (Estancia San Isidro), Agua de Los Pajaritos, *R. Leal 23131* (BAA); Dpto. Tunuyan (Camino al Paso del Postillo nieudocino), Cuesta de Los Afligidos, *R. Leal 1879* (BAA); Dpto. Las Heras, Paramillo de Uspallata, *R. Leal 18717* (BAA); above Villavicencio, *T. W. Böcher et al. 2141* (BAA).

4. **Physaria urbaniana** (Muschler) O'Kane & Al-Shehbaz, comb. nov. Basionym: *Alyssum urbanianum* Muschler, Bot. Jahrb. Syst. 40: 274. 1908. TYPE: Bolivia. Tarija: Escayache near Tarija, 3600 m, 1 Feb. 1904, *K. Fiebrig 3034* (holotype, M; isotypes, BM, E, GH, K).

Alyssum boliviense Muschler, Bot. Jahrb. Syst. 40: 274. 1908. Syn. nov. TYPE: Bolivia. Puna Patanca, 3700 m, 8 Jan. 1904, *K. Fiebrig 2619* (holotype, M; isotypes, BM, E, GH, K).

Perennial herbs, densely silvery pubescent throughout with stellate trichomes; caudex thick, woody, simple or branched, often with leaf remnants of previous years, branches terminated by leaf clusters; stems few to many, procumbent or decumbent, 3–13(–15) cm long. Basal leaves subsessile or with petioles rarely to 1 cm long; leaf blade spatulate to narrowly oblanceolate, rarely broadly spatulate or obovate, 1–3(–5) cm × 2–3.5(–5) mm, base attenuate, margin entire, apex obtuse to subacute; cauline leaves (5 to)7 to 18(to 28), secund, spatulate to narrowly oblanceolate, base attenuate, margin entire, apex obtuse. Raceme (4- or)5- to 9(to 13)-flowered, subcorymbose or rarely elongated considerably in fruit; fruiting pedicels sigmoid or rarely straight, divaricate or rarely ascending, densely pubescent, slender, 5–13 mm long. Sepals narrowly oblong, non-saccate at base, silvery pubescent, 5–7.5 × 1.5–2 mm, caducous; petals pale to bright yellow, drying pink or purple, obovate, 8–10(–13) × 3.5–5.5(–7) mm, apex rounded; filaments 4.5–6 mm long; anthers oblong, 1–1.5 mm long. Fruit ellipsoid to ovoid, (6.5–)7–9(–10) × (4–)5–7 mm, angustiseptate, sparsely pubescent, sessile or minutely stipitate, base obtuse to subcordate, apex subacute; ovules/seeds (3 or)4 to 6 per locule; style slender, (2.5–)3–5(–6.5) mm long, glabrous or sparsely pubescent basally; stigma only

slightly wider than style; seeds compressed, ovate to ovate-orbicular, wingless, (1.5–)2–2.5 × (1–)1.5–2 mm; cotyledons accumbent.

Phenology, distribution, and elevation. Flowering mid November through January, fruiting December to late February (rarely early April) in Argentina (Catamarca, Jujuy, La Rioja, Mendoza, Salta, and Tucumán) and southern Bolivia at (2000–)2300–4000(–4400) m.

A critical examination of the type collections of *Alyssum boliviense* and *A. urbanianum* reveals that they represent a single species and were based on flowering and fruiting material, respectively. Muschler (1908) indicated that the two species differ in leaf shape and in having petiolate (*A. boliviense*) instead of sessile (*A. urbanianum*) leaves, but these differences show continuous variation within the species.

Two collections, *Venturi 6607* and *7413* (both at US), have thick and long styles (6–6.5 mm), and the labels state that the flowers are white. White flowers are rare in *Physaria*, and more fieldwork is needed to confirm the identity of these collections because they have immature fruits. It is quite possible that the material represents an undescribed taxon. In other plants of *P. urbaniana*, the style reaches a maximum length of 5 mm. In general, plants of this species have short stems, apparently growing primarily between rocks and in rock crevices, but in a few collections (e.g., *Araque & Barkley 19Ar159* (F) and *Jörgensen 1062* (A, GH, MO, US)) the plants are about 15 cm long. Broadly spatulate to obovate basal leaves are rather rare in the species and were observed thus far only in *Böcher et al. 1407* (BAA).

Specimens examined. ARGENTINA. **Catamarca:** Dpto. Pomán, en el camino desde Los Ciénegos al Alto de la Cruz, 22 km al SSE de Pomán, *Vervoorst 3449* (W); Acongria, *H. & O. Brücher s.n.* (S); Dpto. Belén, Faldeos al N del Portezuelo del Rio Blanco, arriba de Granadillas, *Sleumer & Vervoorst 2587* (BAA, LIL, US); Comun Cerro negro, *Jörgensen 1062* (A, GH, MO, US); Dept. Santa Maria, Sierra de Onconquija, *Venturi 6607* (US). **Jujuy:** Esquinas Blancas, *Shapiro s.n.* (GH); Dpto. Humahuaca, Mina Aquilar, entre Tres Cruces y Molino, *Ruthsatz 9753* (BAA); Dpto. Cochinoca, camino de Casas Grandes a la Mina A. Espinosa del Diablo, *Ancibor & Mujica 15* (BAA, GH); Dpto. Tumbaya, Abra Portillo, Rt. 52, *Nicora et al. 8821* (SI); Dept. Zilcara, Zilcara, *Venturi 7413* (US). **La Rioja:** Sierra de Famatina, Pampa de Chilitauca, *Krapovickas & Hunziker 5224* (BAA); Quebrada de Potrerillos, *Krapovickas & Hunziker 5410* (BAA). **Mendoza:** Tres Lagunas, frente a la vertiente occidental de la Cuchilla de la Tristeza, *Castellanos 47495* (US); Atuel Valley, 30 km from El Sosneado, *Böcher et al. 1407* (BAA). **Salta:** Dpto. Iruya, ca del cruce del camino a Bovazuli, *Bliarpin & Novara 23183* (MO); Dept. Cafayate, Sierra de los Quilmes, 1 Jan. 1943, *Castellanos s.n.* (GH); Dpto. San Carlos, Cerro de Cachi, *Venturi 6744* (US). **Tucumán:** Dep. Tafí, Infiernillo, Quebrada Honda, *Petersen & Hjerting 799* (BAA); Infiernillo, *Krapovickas & Cristóbal 20518* (CTES), *Hjerting et al. 9405* (BAA); 25 km N of Tufí del Valle on road to Amaicha del Valle, *Hammel 5933* (MO); Tafí del Valle, *Calderá et al. 67* (BAA), *Araque & Barkley 19Ar159* (F); Cerro pelado, *Sleumer 157* (B); Sa. Aconquija, El Infiernillo, *Hunziker 7247* (GH); Co. El Negrito (ladera S.E.), *Giusti et al. 3868* (BAA); El Infiernillo-Alrededores del mástil, *Figuiroa et al. 254* (LIL); Angostura, *Solbrig 4200* (GH); Lara, *Rodriguez 296* (BA, GH); Dept. Chicligaasta, Estancia Santa Rosa, *Venturi 7608* (US); campo de la flora San José, *Schreiter 7016* (A).

5. Physaria pygmaea O'Kane & Al-Shehbaz, sp. nov. TYPE: Argentina. Tucumán: Dpto. Tafí, cumbres Calchaquíes, Huaca Huasi, 4300 m, 26°40′S, 65°44′W, 13 Mar. 1984, *E. Gómez-Sosa & M. Múlgura 189* (holotype, MO; isotypes, ISTC, SI). Figure 3.

Herba perennis minuta, 0.5–1(–1.3) cm longa, caudicibus crassis, simplicibus; caules procumbentes vel decumbentes. Folia basalia integra; folia caulina nulla vel 1–3(–4). Racemi 1–3(–4)-flori; pedicelli fructiferi recti vel curvati, 3–6 mm longi. Petala obovata, 4–5(–6) × ca. 2 mm. Fructus ovoidei, compressi, angustiseptati, 4–5(–8) × 3–4(–5) mm, basi et apice obtusi; stylus tenuis, 2.5–3.5 mm longus; stigma tenue.

Perennial, tiny herbs, silvery pubescent throughout with stellate trichomes; caudex thick, woody, simple or rarely few-branched, often with leaf remnants of previous years; stems 1 or few, procumbent, 0.5–1(–1.3) cm long. Basal leaves sessile; leaf blade linear to narrowly oblanceolate, 0.5–1(–1.3) cm × 1–2 mm, base attenuate, margin entire, apex obtuse to subacute; cauline leaves absent or 1 or 3(or 4), secund, linear- to narrowly oblanceolate, base attenuate, margin entire, apex obtuse. Raceme 1- or 3(or 4)-flowered, subcorymbose not elongated in fruit; fruiting pedicels straight or slightly curved, not sigmoid, divaricate, densely pubescent, slender, 3–6 mm long. Sepals narrowly oblong, non-saccate at base, silvery pubescent, 3–4 × ca. 1 mm, caducous; petals pale to bright yellow, obovate, 4–5(–6) × ca. 2 mm, apex rounded; filaments 3–4 mm long; anthers oblong, ca. 1 mm long. Fruit ovoid, 4–5(–8) × 3–4(–5) mm, angustiseptate, sparsely pubescent, sessile, base and apex obtuse; ovules/seeds 4 to 6 per locule; style slender, 2.5–3.5 mm long, glabrous; stigma only slightly wider than style; seeds compressed, orbicular to ovate-orbicular, wingless, 1.5–2.5 × 1–1.5 mm; cotyledons accumbent.

Phenology, distribution, and elevation. Flowering mid December through January, fruiting January to early March in Argentina (Tucumán, Jujuy, and La Rioja) at 2500–4300 m.

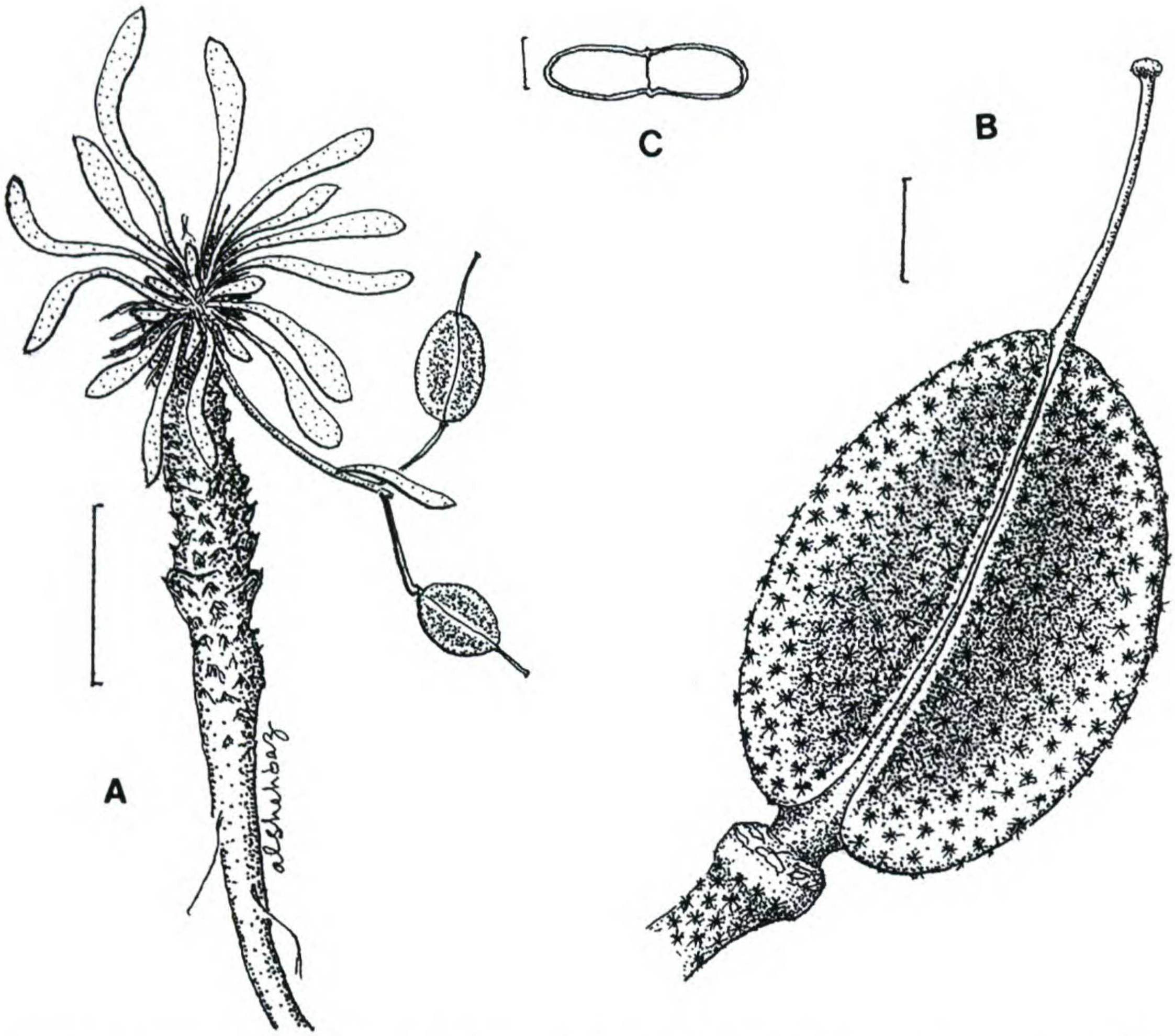

Figure 3. *Physaria pygmaea* O'Kane & Al-Shehbaz. —A. Plant. —B. Fruit. —C. Diagrammatic cross section of fruit. Scale: A = 1 cm; B, C = 1 mm. Drawn by Al-Shehbaz from the holotype, *Gómez-Sosa & Múlgura 189* (MO).

Physaria pygmaea appears to be most closely related to *P. urbaniana*, which it resembles in having angustiseptate fruits and entire leaves. It is a much smaller plant with short, leafless or 1- to 3(or 4)-leaved fruiting stems rarely reaching 1.3 cm in length, 1- to 3(or 4)-flowered racemes, smaller petals 4–5(–6) × ca. 2 mm, non-sigmoid fruiting pedicels, and small fruits 4–5(–8) × 3–4(–5) mm. By contrast, *P. urbaniana* has (5- to)7- to 18(to 28)-leaved stems 3–13(–15) cm long, (4- or)5- or 9(to 13)-flowered racemes, larger petals 8–10(–13) × 3.5–5.5(–7) mm, sigmoid fruiting pedicels, and larger fruits (6.5–)7–9(–10) × (4–)5–7 mm.

Paratypes. ARGENTINA. **Jujuy:** Dpto. Humahuaca, Mina Aquilar, Espinozo del Diablo, *B. Ruthsatz 278* (BAA); entre Tres Cruces y Molino, *B. Ruthsatz 9752* (BAA); Dpto. Cochinoca, Espinazo del Diablo, *E. Ancibor & B. Ruthsatz 2046* (BAA); Tilcara, arriba de San Gregorio, *H. Sleumer 3134* (BAA). **La Rioja:** La Hoyada, Sierra Famatina arriba de Vallecito, *J. Jimenez s.n.* (GH).

Acknowledgments. We are grateful to Henk van der Werff for correcting the Latin, to Carmen Ulloa for translating the abstract into Spanish, and to Anthony R. Brach and Kanchi Gandhi for providing needed literature. We are much indebted to Victoria C. Hollowell, Thomas G. Lammers, and an anonymous reviewer for their critical review of the manuscript. We thank the directors and curators of the herbaria cited in this account.

Literature Cited

Al-Shehbaz, I. A. & S. L. O'Kane, Jr. 2002. *Lesquerella* is united with *Physaria* (Brassicaceae). Novon 12: 319–329.

Anderson, J. L., J. L. Reveal & R. C. Rollins. 1997. *Lesquerella vicina* (Brassicaceae), a new species from the Uncompahgre River Valley in western Colorado. Novon 7: 9–12.

Barnéoud, F. M. 1846. Cruciferae. Pp. 105–185 *in* C. Gay, Historia Física y Política de Chile, Vol. 1, Botany. Paris, Santiago.

Boelcke, O. 1967. Cruciferae. Pp. 281–371 *in* A. L. Cabrera (editor), Flora de la Provincia de Buenos Aires, Vol. 4, pt. 3. Buenos Aires.

——— & C. Romanczuk. 1984. Cruciferae. Fl. Patagonica, Vol. 4A: 373–544. INTA, Buenos Aires.

Eichler, A. G. 1865. Cruciferae. Pp. 293–338 *in* C. F. Martius (editor), Fl. Brasil, Vol. 13, pt. 1. München, Wien, Leipzig.

Kurtz, F. 1893. Sertum Cordobense—Observaciones Sobre Plantas Nuevas, Raras ó Dudosas de la Provincia de Córdoba. Revista Mus. La Plata 5: 283–303.

Manton, I. 1932. Introduction to the general cytology of the Cruciferae. Ann. Bot. II, 46: 509–556.

Muschler, R. 1908. Cruciferae andinae. Bot. Jahrb. Syst. 40: 267–277.

O'Kane, S. L., Jr. 1999. *Lesquerella navajoensis* (Brassicaceae), a new species of the *L. hitchcockii* complex from New Mexico. Madroño 46: 88–91.

——— & I. A. Al-Shehbaz. 2002. *Paysonia*, a new genus segregated from *Lesquerella* (Brassicaceae). Novon 12: 379–381.

———, ——— & N. J. Turland. 1999. (1393) Proposal to conserve the name *Lesquerella* against *Physaria* (Cruciferae). Taxon 48: 163–164.

Payson, E. B. 1921 [issued 1922]. A monograph of the genus *Lesquerella*. Ann. Missouri Bot. Gard. 8: 103–236.

Philippi, R. A. 1864. Plantarum novarum Chilensium: Centuriae, inclusis quibusdam Mendocinis et Patagonicis. Linnaea 33: 1–308.

Rollins, R. C. 1939. The cruciferous genus *Physaria*. Rhodora 41: 392–415.

———. 1993. The Cruciferae of Continental North America. Stanford Univ. Press, Stanford.

———. 1995. Two Lesquerellas (Cruciferae) of south central and western Montana. Novon 5: 71–75.

——— & E. A. Shaw. 1973. The Genus *Lesquerella* (Cruciferae) in North America. Harvard Univ. Press, Cambridge.

———, K. A. Beck & F. E. Caplow. 1996. An undescribed species of *Lesquerella* (Cruciferae) from the State of Washington. Rhodora 97: 201–207.

Schulz, O. E. 1934. Neue Cruciferen aus Südamerika. Notizbl. Bot. Gart. Berlin-Dahlem 12: 39–41.

———. 1936. Cruciferae. Pp. 227–658 *in* A. Engler & H. Harms (editors), Die Natürlichen Pflanzenfamilien, Vol. 17B. Verlag von Wilhelm Engelmann, Leipzig.

Watson, S. 1888. Contributions to American botany. XVII. 1. Some new species of plants of the United States, with revisions of *Lesquerella* (*Vesicaria*) and of the North American species of *Draba*. Proc. Amer. Acad. Arts 23: 249–267.